

## **CLAIMS**

*What is claimed is:*

1. A method of transcoding a source structured document in a markup language into one or more ordered and hierarchically related structured data, each being suitable for a browser to render a display page while satisfying constraints from a display area and processing capacity of a browser device, the method comprises the steps of: a) building a document tree from said source structured document; b) generating a plurality of new document trees from said document tree such that said new document trees are ordered and hierarchically linked; c) scaling sizing attributes of each tree node of said new document trees thereby satisfying said constraints for each of said new document trees; and d) producing, from each new document tree, one structured data such that it is suitable for input to said browser.
2. The method of claim 1 wherein each of said document trees further comprises only one root node and more than one leaf nodes, each said node except the root node has one and only one parent node and each said node except the leaf node has at least one child node.
3. The method of claim 2 wherein each of said leaf nodes of said new document tree belongs to one and only one of said new document trees.
4. The method of claim 3 wherein the step of b) further comprises one or more of the following steps: assigning layout constraints and sizing parameters to each tree node of said document tree; splitting an oversized tree node of said document tree into a plurality of newly added tree nodes thereby making each of said newly added tree nodes satisfy a size constraint or partitioning an oversized tree node of said document tree thereby adding a new document tree that satisfies a size constraint; and ordering said new document trees in an order consistent with a two-dimensional navigation sequence of said display page for said source structured document.
5. The method of claim 4 wherein said two-dimensional navigation sequence is top-to-down coupled with either left-to-right or right-to-left.

6. The method of claim 1 wherein the step of a) further comprises generating a document element list from said source structured document; constructing a content element tree from a subset of said document element list; and completing said document tree from said content element tree and all remaining document elements not in said subset wherein each tree node of said document element tree is associated with a single document element or two paired document elements from said document element list.

7. The method of claim 6 wherein said document element is either a data element or a markup element.

8. The method of claim 6 wherein said data element contains either a text content or script codes.

9. The method of claim 6 wherein each document element within the subset of said document element list is a layout element.

10. The method of claim 6 wherein the step of generating a document element list further comprises parsing said source structured document into said document element list; expanding additional structured document from a document element; and inserting said additional structured document back into said source structured document.

11. The method of claim 10 wherein the steps of parsing, expanding, and inserting are iteratively invoked, one after another per iteration, until said source structured document is completely parsed.

12. The method of claim 10 wherein the step of parsing further comprises filtering document elements so as to exclude them from said document element list.

13. The method of claim 10 wherein the step of expanding further comprises fetching

a hyperlinked structured document as specified in said document element.

14. The method of claim 13 wherein the step of fetching further comprises sending an HTTP request and receiving an HTTP response.

15. The method of claim 13 wherein the step of fetching further comprises sending an HTTPS request and receiving an HTTPS response.

16. The method of claim 13 wherein said document element is a FRAME element, an IFRAME element or a SCRIPT element.

17. The method of claim 10 wherein the step of expanding further comprises executing script codes as specified in said document element based on a document object model.

18. The method of claim 4 wherein the step of partitioning further comprises the steps of selecting a set of descendant nodes of said oversized tree node such that each selected descendant node belongs to at least one layout constraint assigned to said oversized tree node; establishing a partition tree by copying or relocating tree nodes from said document tree to said partition tree such that (i) each sub tree rooted at any tree node within said selected set of descendant nodes gets removed from said document tree; (ii) an ancestor tree node of any tree node within said selected set of descendant nodes wherein the ancestor tree node having more than one child nodes copied from said document tree; and (iii) ordering relationships among the tree nodes of said partition tree is the same as that of said document tree; and inserting cross linking nodes to said partition tree and said document tree thereby creating a corresponding hierarchical linking relationship.

19. The method of claim 4 wherein said ordering step further comprises inserting cross-linking nodes to said new document tree thereby causing each said new document tree resulting from the step of partitioning to have references to its neighboring new document trees according to said order.

20. The method of claim 1 wherein the step of scaling further comprises the steps of assigning a target browser display width to the root node of each said new document tree as a maximum width allowed for said root node; deciding a maximum width allowed for each said tree node given the maximum width allowed for its parent node such that the value of said minimum width sizing parameter assigned to said parent node is no greater than the given maximum width; determining a scaling factor, no greater than 1, for each said tree node; and applying said scaling factor to sizing attributes of said document elements associated with said tree node.

21. The method of claim 17 wherein said document object model is a simplified document object model.

22. The method of claim 6 wherein each tree node of said document element tree is associated with a single data element, two paired markup elements or a single markup element.

23. The method of claim 6 wherein the step of completing further comprises modifying said document element tree such that no tree node corresponds to a single style element or a single context element.

24. The method of claim 6 wherein the step of completing further comprises the step of converting said document element tree into a new document element tree, such that each tree node of said new document element tree is associated with a data element, a single markup element or two paired markup elements of a second markup language.

25. The method of claim 1 wherein said markup language is HTML.

26. The method of claim 24 herein said second markup language is HTML, CHTML, XHTML, XML, WML or HDML.

27. The method of claim 26 wherein the step of converting converts a tree node associated with paired FRAMESET elements into another tree node associated with paired TABLE elements.
28. The method of claim 26 wherein the step of converting converts a tree node associated with paired FRAME elements into another tree node associated with paired TD elements.
29. The method of claim 4 wherein said layout constraints assigned to said tree node is a vertical column or a horizontal row over a set of descendant nodes of said tree node and each said tree node is associated with one or more said layout constraints.
30. The method of claim 4 wherein said sizing parameters comprises a scalable width, a minimum width, an image area and a character number.
31. The method of claim 4 wherein the value of said sizing parameter assigned to said tree node is the cumulative summation of corresponding values of the same sizing parameter of all its child nodes.
32. The method of claim 4 wherein the value of said sizing parameter assigned to said tree node is determined as a cumulative summation, over a set of layout constraints assigned to said tree node, of maximum corresponding value of the same sizing parameter within the set of descendant nodes belonging to the same layout constraint.
33. The method of claim 29 wherein the value of said sizing parameter assigned to said tree node is no less than any corresponding value of the same sizing parameter of said descendant nodes belonging to one said vertical column constraint associated with said tree node.

34. The method of claim 29 wherein the value of said sizing parameter assigned to said tree node is no less than a cumulative summation of each corresponding value of the same sizing parameter of said descendant nodes belonging to one said horizontal row constraint associated with said tree node.

35. The method of claim 30 wherein said oversized tree node has a value of said minimum width sizing parameter exceeding a width threshold value.

36. The method of claim 29 wherein said splitting step modifies one horizontal row layout constraint assigned to said oversized tree node.

37. The method of claim 1 wherein said generating step further comprises composing a catalog document tree, containing tree nodes linked to said new document trees, to provide a summary sizing information for each said new document tree and the hierarchical linking relationship amongst said new document trees.

38. The method of claim 1 wherein said structured data is a structured document in a second markup language.

39. The method of claim 1 wherein said browser device is palmtops, PDAs or data-enabled cell phones wirelessly connected with a small display areas and processing capacities.

40. A computer readable medium including instructions for transcoding a source structured document in a markup language into one or more ordered and hierarchically related structured data, each being suitable for a browser to render a display page while satisfying constraints from a display area and processing capacity of a browser device, the instructions comprises: a) building a document tree from said source structured document; b) generating a plurality of new document trees from said document tree such that said new document trees are ordered and hierarchically linked; c) scaling sizing

attributes of each tree node of said new document trees thereby satisfying said constraints for each new document tree; and d) producing, from each new document tree, one structured data such that it is suitable for input to said browser.

41. The computer readable medium of claim 40 wherein each of said document trees further comprises only one root node and more than one leaf nodes, each said node except the root node has one and only one parent node and each said node except the leaf node has at least one child node.

42. The computer readable medium of claim 41 wherein each said leaf node of said document tree belongs to one and only one of said new document trees.

43. The computer readable medium of claim 42 wherein the step b) further comprises one or more of the following steps: assigning layout constraints and sizing parameters to each tree node of said document tree; splitting an oversized tree node of said document tree into a plurality of newly added tree nodes thereby making each of said newly added tree nodes satisfy a size constraint or partitioning an oversized tree node of said document tree thereby adding a new document tree that satisfies a size constraint; and ordering said new document trees in an order consistent with a two-dimensional navigation sequence of said display page for said source structured document.

44. The computer readable medium of claim 40 wherein the step a) further comprises generating a document element list from said source structured document; constructing a content element tree from a subset of said document element list; and completing said document tree from said content element tree and all remaining document elements not in said subset wherein each tree node of said document element tree is associated with a single document element or two paired document elements from said document element list.

45. The computer readable medium of claim 44 wherein the step of generating a document element list further comprises parsing said source structured document into said document

element list; expanding additional structured document from a document element; and inserting said additional structured document back into said source structured document.

46. The computer readable medium of claim 45 wherein the steps of parsing, expanding, and inserting are iteratively invoked, one after another per iteration, until said source structured document is completely parsed.

47. The computer readable medium of claim 43 wherein the step of partitioning further comprises the steps of selecting a set of descendant nodes of said oversized tree node such that each selected descendant node belongs to at least one layout constraint assigned to said oversized tree node; establishing a partition tree by copying or relocating tree nodes from said document tree to said partition tree such that (i) each sub tree rooted at any tree node within said selected set of descendant nodes gets removed from said document tree; (ii) an ancestor tree node of any tree node within said selected set of descendant nodes wherein the ancestor tree node having more than one child nodes copied from said document tree; and (iii) ordering relationships among the tree nodes of said partition tree is the same as that of said document tree; and inserting cross linking nodes to said partition tree and said document tree thereby creating a corresponding hierarchical linking relationship.

48. The computer readable medium of claim 40 wherein the step of scaling further comprises the steps of assigning a target browser display width to the root node of each said new document tree as a maximum width allowed for said root node; deciding a maximum width allowed for each said tree node given the maximum width allowed for its parent node such that the value of said minimum width sizing parameter assigned to said parent node is no greater than the given maximum width; determining a scaling factor, no greater than 1, for each said tree node; and applying said scaling factor to sizing attributes of said document elements associated with said tree node.

49. The computer readable medium of claim 44 wherein the step of completing further comprises the step of converting said document element tree into a new document



element tree, such that each tree node of said new document element tree is associated with a data element, a single markup element or two paired markup elements of a second markup language.

50. The computer readable medium of claim 40 wherein said markup language is HTML.

51. The computer readable medium of claim 49 wherein said second markup language is HTML, CHTML, XHTML, XML, WML or HDML.

52. The computer readable medium of claim 43 wherein said layout constraints assigned to said tree node is a vertical column or a horizontal row over a set of descendant nodes of said tree node and each said tree node is associated with one or more said layout constraints.

53. The computer readable medium of claim 43 wherein said sizing parameters comprises a scalable width, a minimum width, an image area and a character number.

54. The computer readable medium of claim 43 the value of said sizing parameter assigned to said tree node is the cumulative summation of corresponding values of the same sizing parameter of all its child nodes.

55. The computer readable medium of claim 43 wherein the value of said sizing parameter assigned to said tree node is determined as a cumulative summation, over a set of layout constraints assigned to said tree node, of maximum corresponding value of the same sizing parameter within the set of descendant nodes belonging to the same layout constraint.

56. The computer readable medium of claim 52 wherein the value of said sizing parameter assigned to said tree node is no less than any corresponding value of the same sizing parameter of said descendant nodes belonging to one said vertical column

constraint associated with said tree node.

57. The computer readable medium of claim 52 wherein the value of said sizing parameter assigned to said tree node is no less than a cumulative summation of each corresponding value of the same sizing parameter of said descendant nodes belonging to one said horizontal row constraint associated with said tree node.

58. The computer readable medium of claim 53 wherein said oversized tree node has a value of said minimum width sizing parameter exceeding a width threshold value.

59. The computer readable medium of claim 52 wherein said splitting step modifies one horizontal row layout constraint assigned to said oversized tree node.

60. The computer readable medium of claim 40 wherein said generating step further comprises composing a catalog document tree, containing tree nodes linked to said new document trees, to provide a summary sizing information for each said new document tree and the hierarchical linking relationship amongst said new document trees.

61. The computer readable medium of claim 40 wherein said structured data is a structured document in a second markup language.

62. The computer readable medium of claim 40 wherein said browser device is palmtops, PDAs or data-enabled cell phones wirelessly connected with a small display areas and processing capacities.